AN 211108

DSA SWR Improvement Matching Circuits for over 4GHz

Application Notes

BeRex offers SWR(S11, S22) improvement circuits on the BDA4620, BDA4630, BDA4700, BDA4710 and BDA4730.
This application note explains the method to improve Input / output Return loss of 4GHz and above.
It will be helpful when using a frequency band of 4GHz or higher.
For more detailed product specifications, please check the datasheet.

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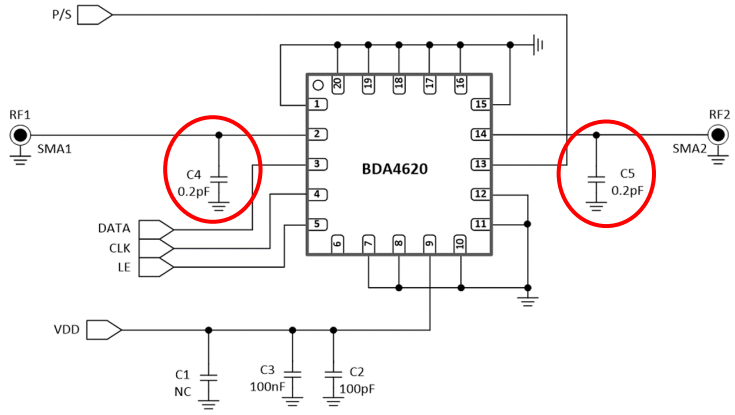
DSA SWR Improvement Matching Circuits for over 4GHz

1. BDA4620

Application Schematic



Reference	Part	Value	Remark
C1	Capacitor	NC	
C2	Capacitor	100nF	
C3	Capacitor	100pF	
C4	**Capacitor**	**0.2pF**	**Matching Value**
C5	**Capacitor**	**0.2pF**	**Matching Value**

Figure 1. BDA4620 Application Circuits for SWR improvement of Frequency 4GHz to 6GHz.

Test Results

When 0.2pF of shunt capacitor is added to RF1 and RF2 port, respectively, both S11 and S22 are improved to below –15dB in frequency band 4GHz or higher. Table 1 below shows the BDA4620 S parameter results when shunt 0.2pF is added on BVA4620 EVB.

Test Parameter			3GHz	3.5GHz	4GHz	4.5GHz	5GHz	5.5GHz	6GHz	Remark
S Parameter	Insertion Loss S21 [dB]	ATT=0dB	-0.96	-0.98	-1.03	-1.14	-1.33	-1.49	-1.62	**Figure 2**
		ATT=10dB	-11.05	-11.14	-11.22	-11.36	-11.59	-11.85	-12.08	**Figure 2, 3**
		ATT=20dB	-20.92	-21.01	-21.05	-21.17	-21.38	-21.61	-21.74	**Figure 3**
		ATT=30dB	-30.82	-30.92	-30.96	-31.09	-31.38	-31.71	-31.82	**Figure 3**
		Flatness (ATT=0dB)	0.2dBpp				0.4dBpp			**Figure 2**
	Input Return Loss S11 [dB]	ATT=0dB	-17.56	-18.45	-17.79	-16.45	-15.47	-16.68	-21.03	**Figure 4**
		ATT=10dB	-18.70	-19.05	-19.00	-18.33	-17.25	-16.66	-16.98	**Figure 4**
		ATT=20dB	-17.78	-18.06	-18.00	-17.40	-16.50	-16.12	-16.92	**Figure 4**
		ATT=30dB	-18.28	-18.49	-18.46	-17.83	-16.70	-15.83	-15.80	**Figure 4**
	Output Return Loss S22 [dB]	ATT=0dB	-19.11	-20.39	-19.90	-18.47	-17.56	-19.19	-23.90	**Figure 5**
		ATT=10dB	-19.93	-21.22	-22.48	-22.77	-22.17	-22.05	-23.12	**Figure 5**
		ATT=20dB	-19.55	-20.41	-21.41	-22.01	-21.35	-19.95	-18.89	**Figure 5**
		ATT=30dB	-19.52	-20.35	-21.34	-21.95	-21.28	-19.85	-18.72	**Figure 5**
ATT Accuracy	ATT Error	ATT=10dB	0.09	0.16	0.20	0.22	0.27	0.36	0.46	
		ATT=20dB	-0.04	0.03	0.03	0.03	0.06	0.13	0.12	
		ATT=30dB	-0.14	-0.06	-0.06	-0.05	0.06	0.23	0.19	
	ATT Accuracy		±(0.25 +3.5% of attenuation state)				±(0.25 +5.0% of attenuation state)			

Table 1. BDA4620 S parameter Test Results

Test Results (Graph)

Figure 2. S21 (ATT = 0dB) : Added 0.2pF Shunt

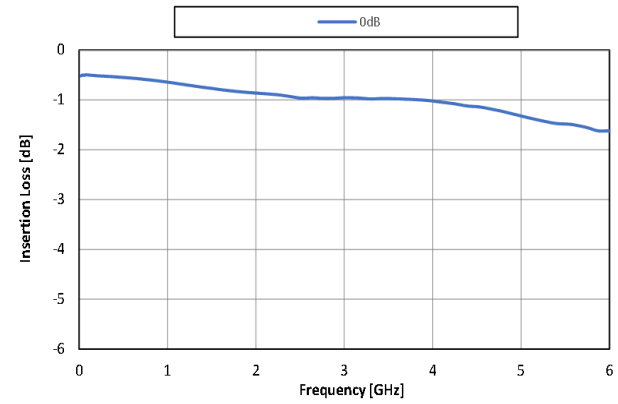


Figure 3. S21 (ATT = 0dB, 10dB, 20dB, 30dB) : Added 0.2pF Shunt

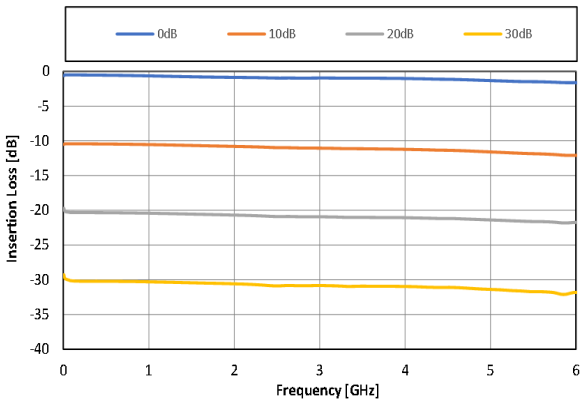


Figure 4. S11 (ATT = 0, 10, 20, 30dB) : Added 0.2pF Shunt.

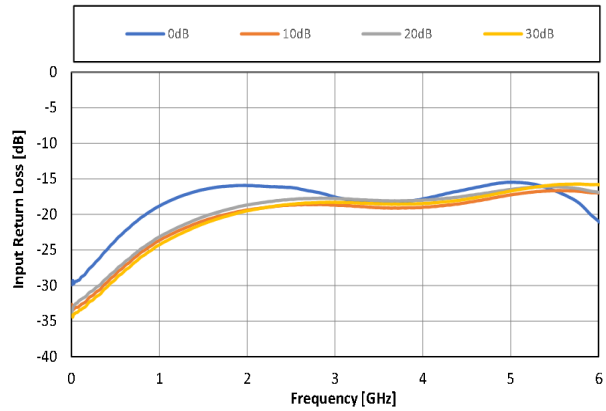


Figure 4-1. S11 : No matching, datasheet graph

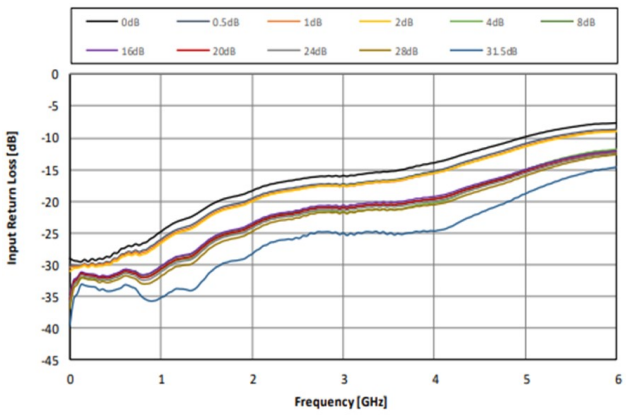


Figure 5. S22 (ATT = 0, 10, 20, 30dB) : Added 0.2pF Shunt.

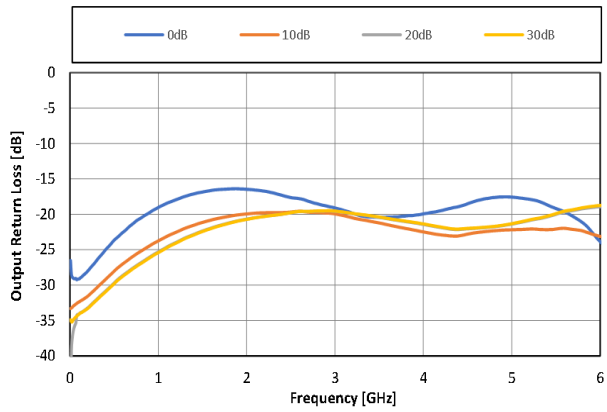
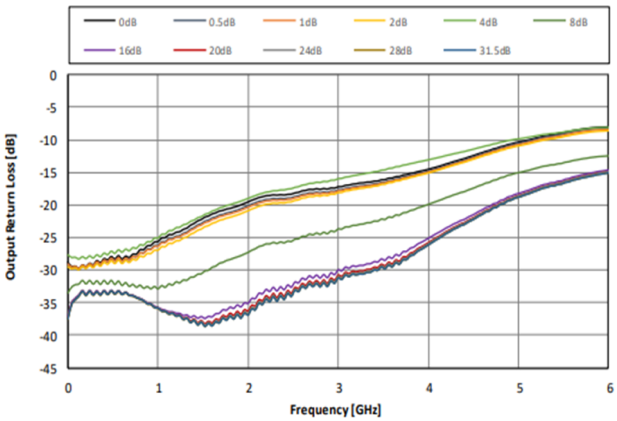
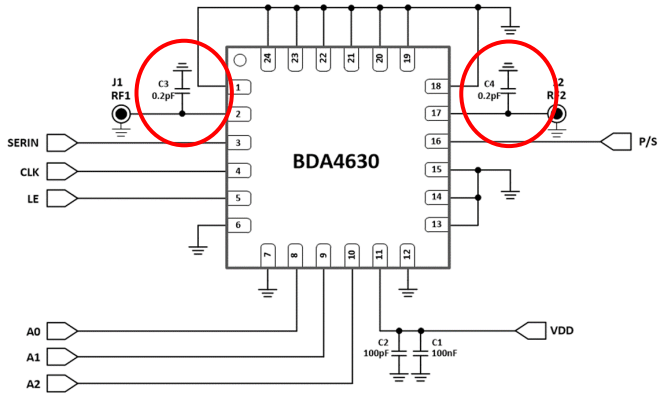


Figure 5-1. S22 : No matching state, datasheet graph



2. BDA4630

Application Schematic



Reference	Part	Value	Remark
C1	Capacitor	NC	
C2	Capacitor	100nF	
C3	**Capacitor**	**0.2pF**	**Matching Value**
C4	**Capacitor**	**0.2pF**	**Matching Value**

Figure 6. BDA4630 Application Circuits for SWR improvement of Frequency 4GHz to 6GHz.

Test Results

When 0.2pF of shunt capacitor is added to RF1 and RF2 port, respectively, both S11 and S22 are improved to below –15dB in frequency band 4GHz or higher. Table 2 below shows the BDA4630 S parameter results when shunt 0.2pF is added on BVA4630 EVB.

Test Parameter			3GHz	3.5GHz	4GHz	4.5GHz	5GHz	5.5GHz	6GHz	Remark
S Parameter	Insertion Loss S21 [dB]	ATT=0dB	-1.04	-1.04	-1.02	-1.10	-1.29	-1.38	-1.60	**Figure 7**
		ATT=10dB	-11.14	-11.28	-11.34	-11.47	-11.68	-11.84	-12.07	**Figure 7, 8**
		ATT=20dB	-21.13	-21.26	-21.29	-21.38	-21.58	-21.68	-21.80	**Figure 8**
		ATT=30dB	-31.08	-31.23	-31.28	-31.37	-31.67	-31.83	-31.88	**Figure 8**
		Flatness (ATT=0dB)	0.2dBpp				0.4dBpp			**Figure 7**
	Input Return Loss S11 [dB]	ATT=0dB	-15.18	-16.90	-18.93	-20.45	-21.92	-25.62	-38.21	**Figure 9**
		ATT=10dB	-17.28	-17.47	-18.06	-18.69	-19.11	-19.68	-20.84	**Figure 9**
		ATT=20dB	-16.59	-16.72	-17.33	-18.01	-18.60	-19.55	-21.83	**Figure 9**
		ATT=30dB	-17.08	-16.96	-17.34	-17.75	-17.98	-18.22	-19.02	**Figure 9**
	Output Return Loss S22 [dB]	ATT=0dB	-16.06	-17.91	-20.13	-22.67	-26.70	-35.44	-26.96	**Figure 10**
		ATT=10dB	-17.97	-18.07	-18.60	-19.43	-20.90	-21.79	-22.94	**Figure 10**
		ATT=20dB	-18.29	-17.88	-17.80	-18.01	-18.41	-18.34	-18.36	**Figure 10**
		ATT=30dB	-18.25	-17.86	-17.74	-17.98	-18.29	-18.13	-18.19	**Figure 10**
ATT Accuracy	ATT Error	ATT=10dB	0.10	0.25	0.32	0.37	0.39	0.46	0.48	
		ATT=20dB	0.09	0.23	0.27	0.28	0.29	0.30	0.21	
		ATT=30dB	0.04	0.20	0.26	0.28	0.38	0.45	0.28	
	ATT Accuracy		±(0.25 +3.5% of attenuation state)				±(0.25 +5.0% of attenuation state)			

Table 2. BDA4630 S parameter Test Results

Test Results (Graph)

Figure 7. S21 (ATT = 0dB) : Added 0.2pF Shunt

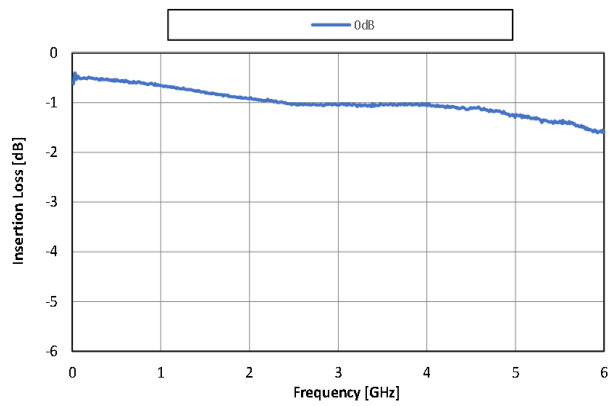


Figure 8. S21 (ATT = 0dB, 10dB, 20dB, 30dB) : Added 0.2pF Shunt

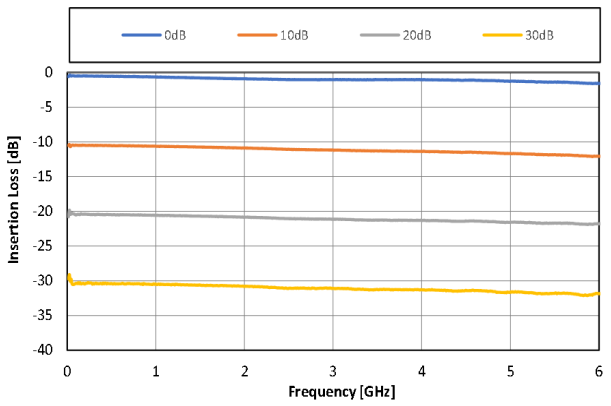


Figure 9. S11 (ATT = 0, 10, 20, 30dB) : Added 0.2pF Shunt.

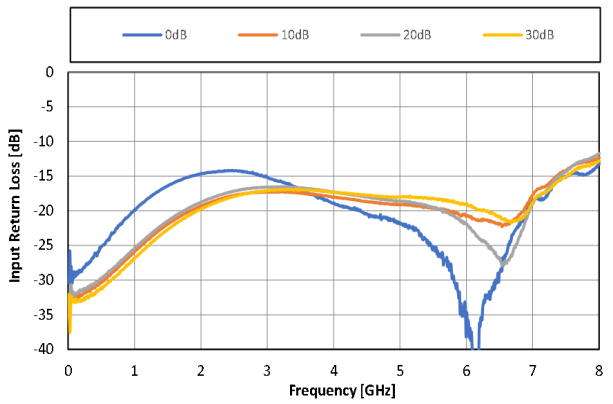


Figure 9-1. S11 : No matching, datasheet graph

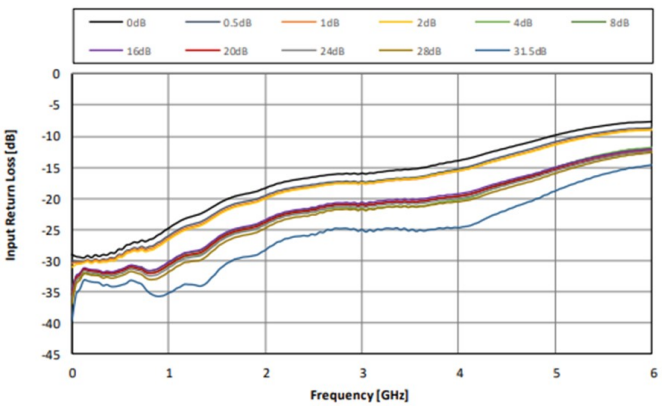


Figure 10. S22 (ATT = 0, 10, 20, 30dB) : Added 0.2pF Shunt.

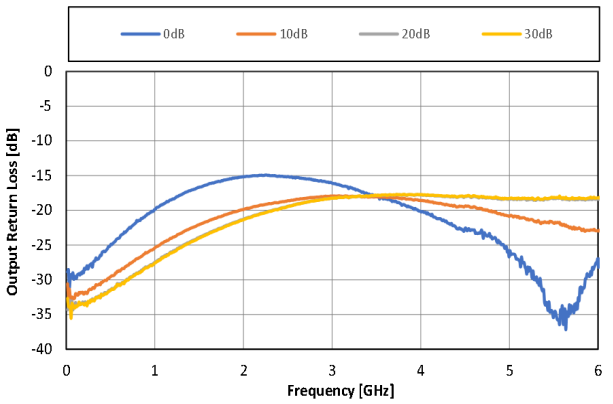
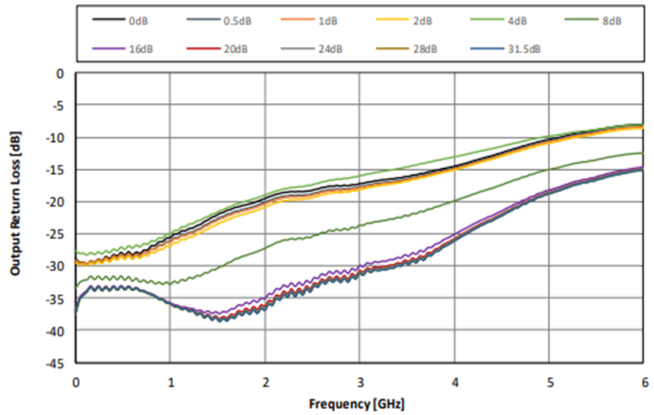
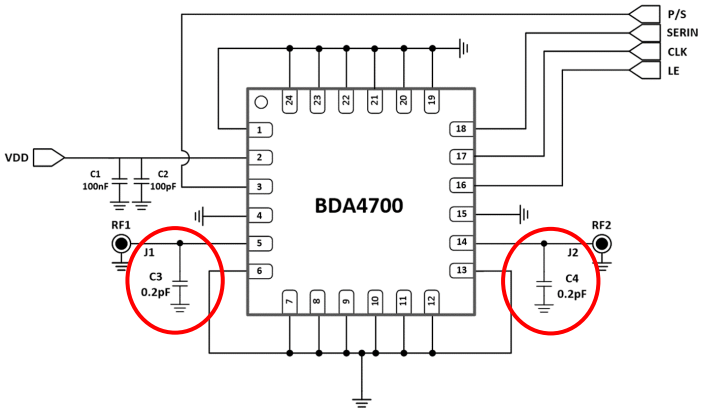


Figure 10-1. S22 : No matching state, datasheet graph



3. BDA4700

Application Schematic



Reference	Part	Value	Remark
C1	Capacitor	100nF	
C2	Capacitor	100pF	
C3	**Capacitor**	**0.2pF**	**Matching Value**
C4	**Capacitor**	**0.2pF**	**Matching Value**

Figure 11. BDA4700 Application Circuits for SWR improvement of Frequency 4GHz to 8GHz.

Test Results

When 0.2pF of shunt capacitor is added to RF1 and RF2 port, respectively, both S11 and S22 are improved to below –15dB in frequency band 4GHz or higher. Table 3 below shows the BDA4700 S parameter results when shunt 0.2pF is added on BVA4700 EVB.

			4GHz	4.5GHz	5GHz	5.5GHz	6GHz	6.5GHz	7GHz	7.5GHz	8GHz	Remark
S Parameter	Insertion Loss S21 [dB]	ATT=0dB	-1.16	-1.29	-1.45	-1.57	-1.62	-1.67	-1.86	-2.24	-2.86	**Figure 12**
		ATT=10dB	-11.49	-11.63	-11.83	-12.04	-12.24	-12.36	-12.50	-12.77	-13.25	**Figure 12,13**
		ATT=20dB	-21.49	-21.60	-21.74	-21.93	-22.09	-22.10	-22.17	-22.30	-22.67	**Figure 13**
		ATT=30dB	-31.79	-31.94	-32.11	-32.37	-32.58	-32.49	-32.71	-32.89	-33.32	**Figure 13**
		Flatness (ATT=0dB)	0.6dBpp					1.2dBpp				**Figure 12**
	Input Return Loss S11 [dB]	ATT=0dB	-18.38	-16.56	-15.18	-15.67	-19.76	-26.02	-18.57	-17.23	-16.41	**Figure 14**
		ATT=10dB	-18.94	-19.43	-18.50	-17.02	-15.75	-14.56	-13.53	-12.61	-11.67	**Figure 14**
		ATT=20dB	-18.24	-18.53	-17.57	-16.50	-16.03	-16.13	-16.41	-15.40	-12.86	**Figure 14**
		ATT=30dB	-18.21	-18.64	-17.66	-16.08	-14.75	-13.83	-13.41	-13.09	-12.36	**Figure 14**
	Output Return Loss S22 [dB]	ATT=0dB	-20.46	-17.68	-15.91	-16.47	-21.45	-29.42	-17.16	-14.37	-12.43	**Figure 15**
		ATT=10dB	-26.91	-24.42	-20.66	-18.95	-18.85	-19.42	-17.87	-14.36	-11.15	**Figure 15**
		ATT=20dB	-22.87	-24.11	-21.00	-17.87	-15.82	-14.69	-14.06	-13.37	-12.08	**Figure 15**
		ATT=30dB	-22.68	-23.98	-20.97	-17.82	-15.72	-14.54	-13.91	-13.28	-12.09	**Figure 15**
ATT Accuracy	ATT Error	ATT=10dB	0.33	0.34	0.38	0.48	0.62	0.69	0.64	0.54	0.39	
		ATT=20dB	0.34	0.31	0.30	0.37	0.47	0.43	0.31	0.07	-0.19	
		ATT=30dB	0.64	0.66	0.67	0.80	0.96	0.82	0.85	0.65	0.46	
	ATT Accuracy		±(0.25 +5.0% of atteunation state)					±(0.25+7.0% of atteunation state)				

Table 3. BDA4700 S parameter Test Results

Test Results (Graph)

Figure 12. S21 (ATT = 0dB) : Added 0.2pF Shunt

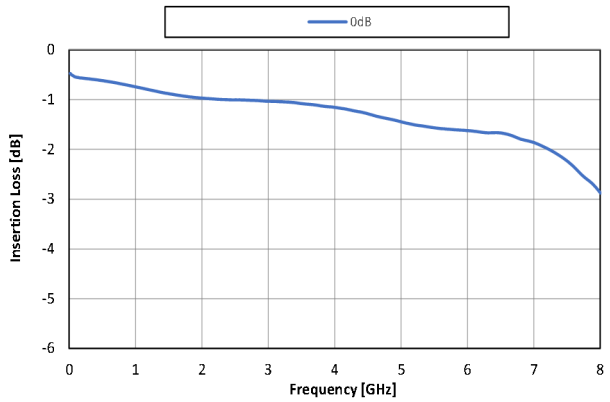


Figure 13. S21 (ATT = 0dB, 10dB, 20dB, 30dB) : Added 0.2pF Shunt

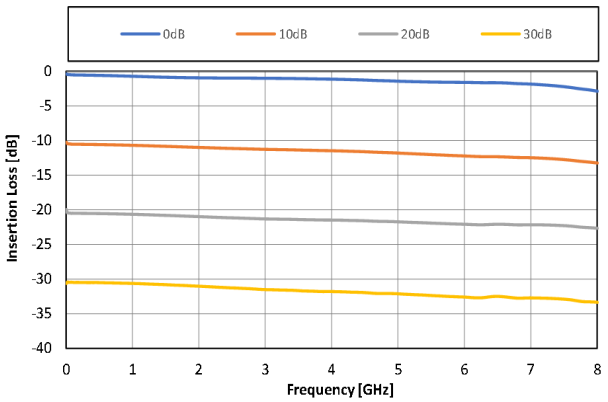


Figure 14. S11 (ATT = 0, 10, 20, 30dB) : Added 0.2pF Shunt.

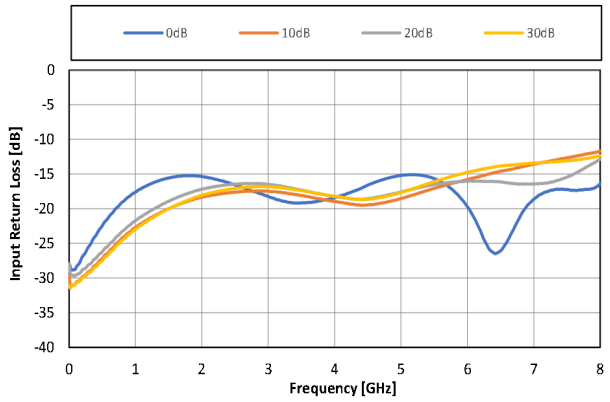


Figure 14-1. S11 : No matching, datasheet graph

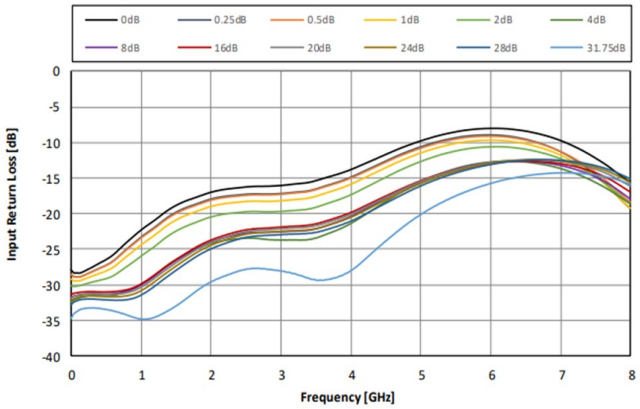


Figure 15. S22 (ATT = 0, 10, 20, 30dB) : Added 0.2pF Shunt.

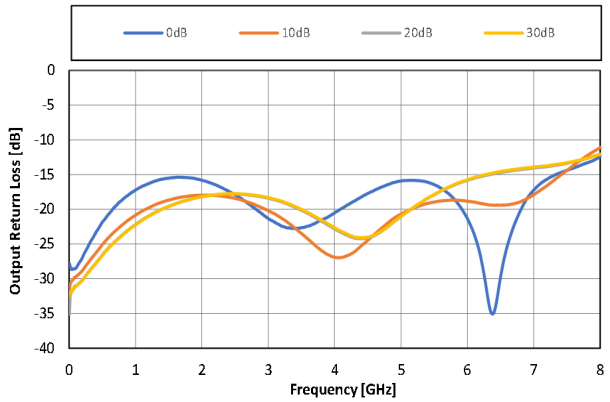
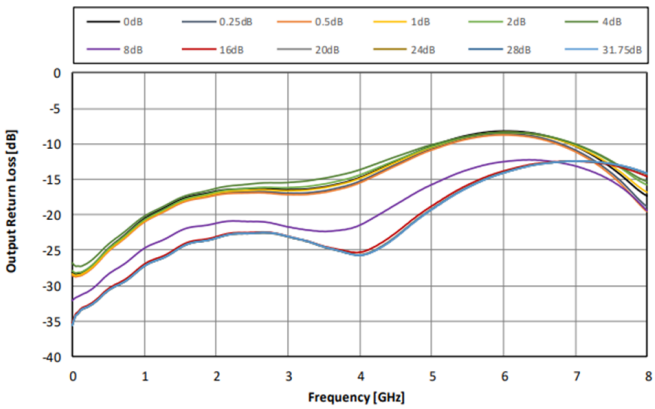
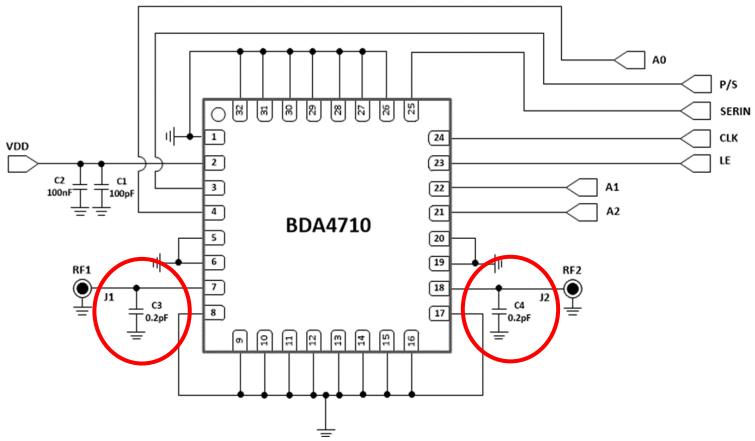


Figure 15-1. S22 : No matching state, datasheet graph



4. BDA4710 / BDA4730

Application Schematic



Reference	Part	Value	Remark
C1	Capacitor	100pF	
C2	Capacitor	100nF	
C3	**Capacitor**	**0.2pF**	**Matching Value**
C4	**Capacitor**	**0.2pF**	**Matching Value**

Figure 16. BDA4710 / BDA4730 Application Circuits for SWR improvement of Frequency 4GHz to 8GHz.

Test Results

When 0.2pF of shunt capacitor is added to RF1 and RF2 port, respectively, both S11 and S22 are improved to below –15dB in frequency band 4GHz or higher. Table 4 below shows the BDA4710 / BDA4730 S parameter results when shunt 0.2pF is added on BVA4710 / BDA4730 EVB.

			4GHz	4.5GHz	5GHz	5.5GHz	6GHz	6.5GHz	7GHz	7.5GHz	8GHz	Remark
S Parame-ter	Insertion Loss S21 [dB]	ATT=0dB	-1.08	-1.16	-1.33	-1.46	-1.66	-1.75	-1.92	-2.24	-2.83	**Figure 17**
		ATT=10dB	-11.38	-11.51	-11.73	-11.86	-12.08	-12.20	-12.35	-12.57	-13.02	**Figure 17,18**
		ATT=20dB	-21.28	-21.39	-21.58	-21.68	-21.82	-21.94	-22.02	-22.13	-22.47	**Figure 18**
		ATT=30dB	-31.51	-31.66	-31.94	-32.09	-32.27	-32.46	-32.51	-32.61	-33.06	**Figure 18**
		Flatness (ATT=0dB)	0.6dBpp					1.2dBpp				**Figure 17**
	Input Return Loss S11 [dB]	ATT=0dB	-17.87	-19.92	-21.20	-21.40	-21.51	-22.23	-21.17	-18.60	-14.62	**Figure 19**
		ATT=10dB	-17.48	-18.71	-20.25	-22.19	-22.74	-21.40	-19.11	-16.43	-13.75	**Figure 19**
		ATT=20dB	-17.17	-19.05	-21.56	-24.89	-28.45	-31.80	-25.17	-18.53	-13.78	**Figure 19**
		ATT=30dB	-16.79	-17.82	-19.08	-20.63	-21.32	-21.13	-19.97	-17.61	-14.71	**Figure 19**
	Output Return Loss S22 [dB]	ATT=0dB	-19.69	-20.87	-21.22	-21.21	-23.22	-33.42	-27.54	-19.09	-13.63	**Figure 20**
		ATT=10dB	-21.12	-21.58	-21.55	-21.19	-21.91	-22.25	-20.14	-16.06	-12.49	**Figure 20**
		ATT=20dB	-19.92	-20.02	-19.61	-18.37	-17.29	-16.23	-15.45	-14.45	-13.06	**Figure 20**
		ATT=30dB	-19.84	-19.92	-19.46	-18.30	-17.17	-16.11	-15.26	-14.34	-13.01	**Figure 20**
ATT Accu-racy	ATT Error	ATT=10dB	0.30	0.36	0.40	0.40	0.42	0.45	0.44	0.33	0.18	
		ATT=20dB	0.21	0.23	0.25	0.23	0.15	0.19	0.10	-0.11	-0.36	
		ATT=30dB	0.43	0.50	0.61	0.63	0.61	0.71	0.59	0.37	0.23	
	ATT Accuracy		±(0.25 +5.0% of atteunation state)					±(0.25+7.0% of atteunation state)				

Table 4. BDA4710 / BDA4730 S parameter Test Results

Test Results (Graph)

Figure 17. S21 (ATT = 0dB) : Added 0.2pF Shunt

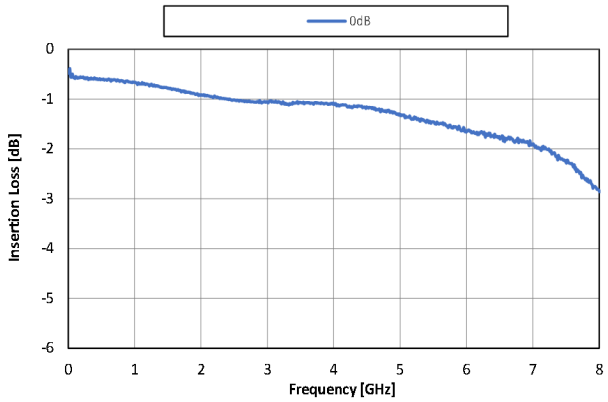


Figure 18. S21 (ATT = 0dB, 10dB, 20dB, 30dB) : Added 0.2pF Shunt

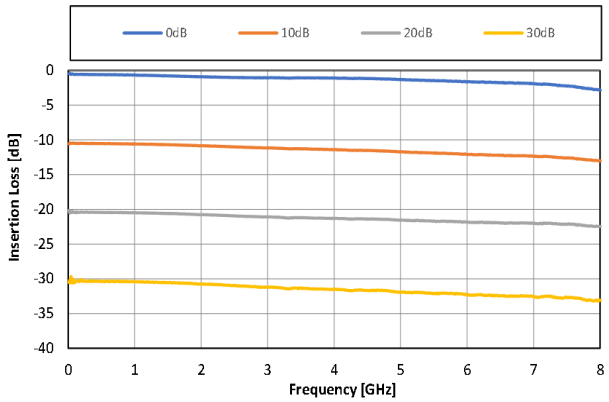


Figure 19. S11 (ATT = 0, 10, 20, 30dB) : Added 0.2pF Shunt.

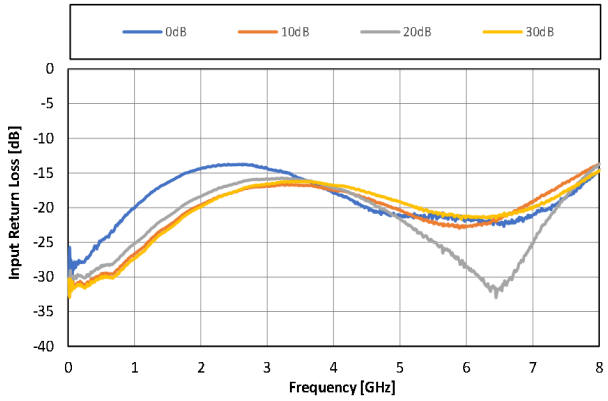


Figure 19-1. S11 : No matching, datasheet graph

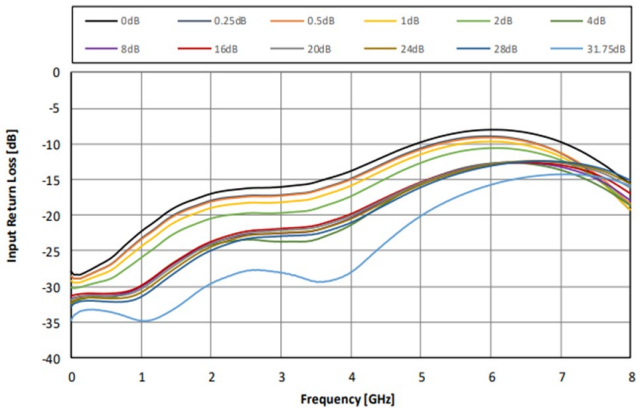


Figure 20. S22 (ATT = 0, 10, 20, 30dB) : Added 0.2pF Shunt.

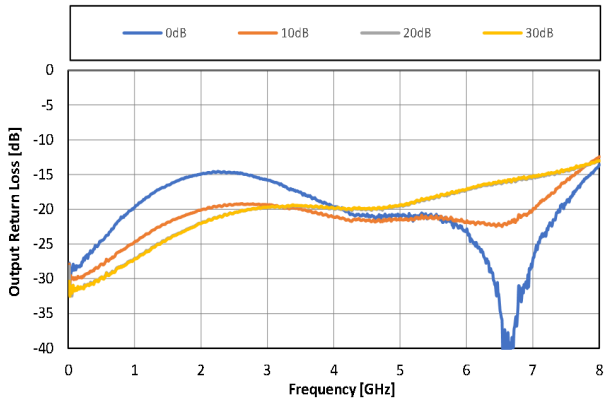


Figure 20-1. S22 : No matching state, datasheet graph